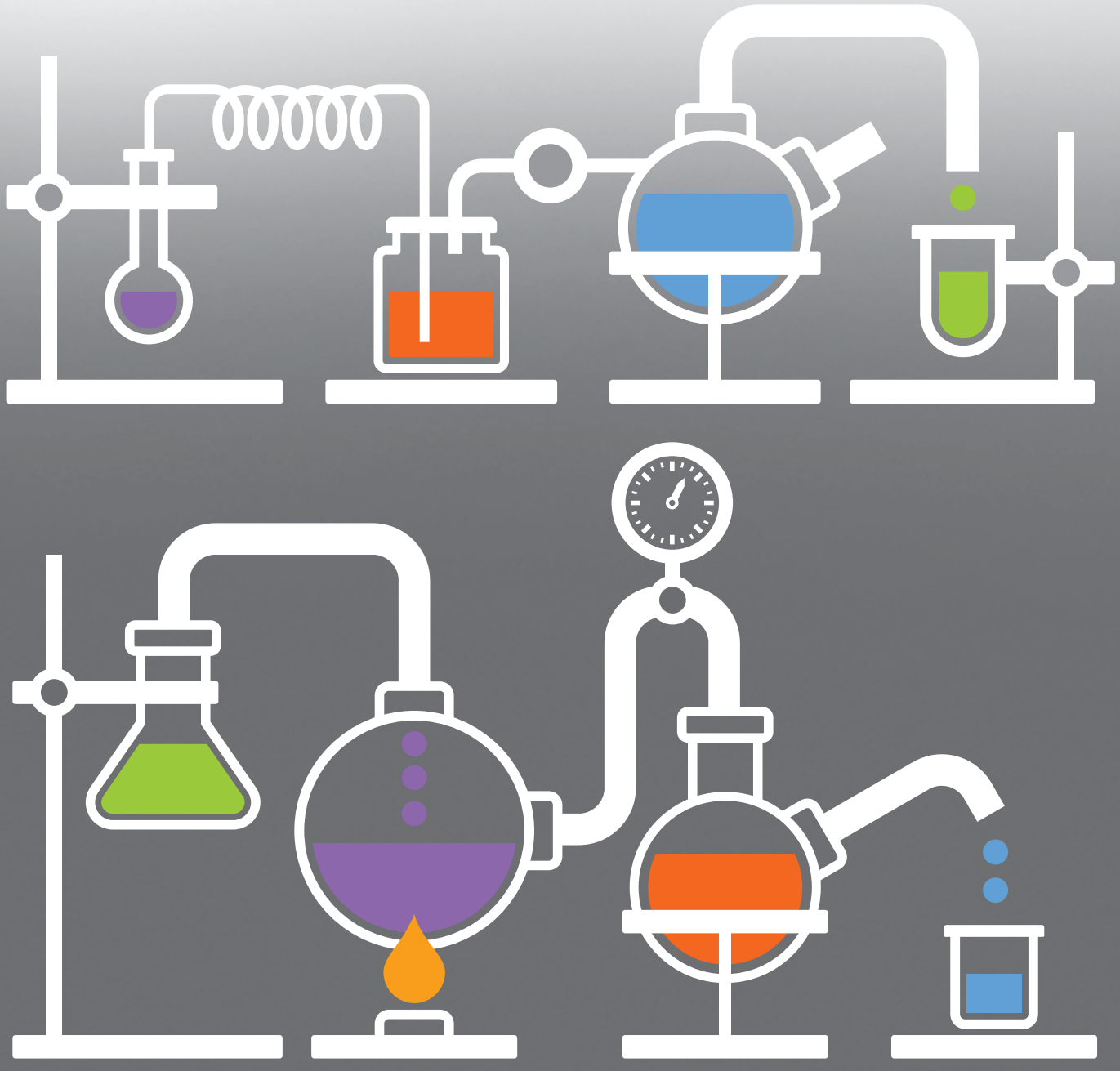
آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD

Setting Up Science Laboratories
Basic Guidelines



For Secondary and Higher Secondary Schools

Compilers: Rooshi Abedi
Kashif Hussain
Afreen Kanwal

Reviewer: Dr Shehzad Jeeva
Zain-ul-Muluk

Editor: Raabia Hirani

Composer: Akber Hashmani

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Section I: Introduction

Importance of Practical Activities

The Aga Khan University Examination Board (AKU-EB) aims to create opportunities to provide students with hands-on experience of laboratory experiments which could bridge the gap between theoretical concepts and its application in everyday life. The laboratory performance is based on the idea that science focuses on hands-on, minds-on observational activities, and that these activities help students in making connections between various scientific concepts and real life experiences. If students are to make use of any technology/ scientific skills in their classrooms, they must learn to

- make observations;
- formulate hypotheses;
- conduct experiments;
- collect data;
- use appropriate tool;
- analyse the data and
- interpret the obtained results.

Following aforementioned steps during practical activities will enable students to make connections to other areas of science and communicate the information effectively and argue their conclusions logically. Students can learn these skills if they are able to participate in a variety of laboratory exercises. The information provided in this document will act as a guide to set up science laboratories which is one of the important criteria for affiliation with AKU-EB. To promote effective teaching and learning, the involvement and commitment on the part of administration and teachers is essential.

Section II: Requirements

The table below indicates the number of units (periods) allocated per week for practical activities to be conducted in a year in the respective subjects.

Table 1: Unit Allocation for Practical Activities per Week

Subject	Units/ Week*
Biology	at least TWO
Chemistry	at least TWO
Physics	at least TWO
Computer Science	at least TWO

*Units/ Week for practical activities (The duration of each unit should not be less than 45 minutes.)

Number of Laboratories

In order to meet the demand for different aspects of science, ideally a school should have one laboratory each for Biology, Chemistry, Physics and Computer Science. The schools with one science laboratory common for Biology, Chemistry and Physics should satisfy the demand of every subject (for instance, minimum 3 sinks, running water supply, gas feed and 6 electrical sockets). If a laboratory must be shared, the science teachers involved should devise a fair schedule which allows sufficient time for each subject.

Laboratory Conditions

Preferably, laboratories should be constructed at a distance from the other classrooms for health and safety reasons.

Each laboratory should offer a minimum accommodation of 6 workstations. The laboratories should have good ventilation, should be well-illuminated and spacious enough to avoid congestion during the practical activities.

In order to accomplish the objectives of the syllabi, the laboratories should be well equipped with necessary apparatus (see Annexure A) and resources such as gas, electricity and water.

It is highly recommended that there should be at least one fume cupboard in the laboratory which is placed away from the workstations for a safe demonstration. A fume cupboard is a ventilated enclosure built into the wall of a laboratory in which harmful and volatile chemicals can be used or stored. In addition, the closed sash protects against splashes of hazardous substances or shattering glass in case of explosion. Thus, the fume cupboard ensures a safe atmosphere in the laboratory.

Chemical Storage and Disposal

It is recommended that the laboratories are provided with a store room for the preparation and storage of reagents. Update inventory of all chemicals on hand at least annually; keep the inventory list up-to-date. Do not store chemicals past the manufacturer's suggested shelf-life. Generally, bottles of chemicals should not remain unused on shelves in the laboratory for more than one week and in the storeroom unused for more than one year. As a good practice, ensure that appropriate disposal procedures for waste chemicals are followed as per environmental protection requirements. Do not purchase or store large quantities of flammable liquids. Never open a chemical container until the label and Material Safety and Data Sheet (MSDS) have been read and completely understood.

According to **American Chemical Society's publication**, preventing accidents with chemicals involves two requirements: knowledge and the habit of safety. Knowledge entails understanding the particular hazardous characteristics of a chemical that will be used. Is it flammable? Is it toxic? Knowledge also means knowing what to do and what to avoid when a chemical is flammable, corrosive or an irritant. Moreover, knowledge includes knowing what to do in case an accident occurs. In addition to knowledge, developing habit of safety is also essential which means following safety rules in the science laboratories by teachers and students.

Precautionary labels for chemicals typically present information in four parts, usually in the order described here. First is a Signal Word: 'Danger', 'Warning', or 'Caution'. Only one of the three should be used on a label.

- **'Danger'** is the strongest of the three and is used when the contents present a potential for serious foreseeable harm.
- **'Caution'** is restricted to chemicals that are foreseeably the least potentially harmful.
- **'Warning'** is for chemicals intermediate in their potential to cause foreseeable harm.

One or more Statements of Hazard follow the Signal Word. These are brief descriptions of the major foreseeable way or ways in which the chemical could cause harm. Examples include:

- 'Flammable'
- 'Harmful if Inhaled'
- 'Causes Severe Burns'
- 'Poison'
- 'May Cause Irritation'

Next on the label are one or more Precautionary Measures, as appropriate. These are brief descriptions of actions to be undertaken or avoided and which, if followed, will prevent the corresponding hazard(s) that are described by the Statements of Hazard. Examples include:

- 'Keep Away from Heat, Sparks, and Flame'
- 'Use with Adequate Ventilation'
- 'Do Not Get in Eyes'
- 'Avoid Breathing Dust'

At the end, the label displays some ways in which one can quickly respond to an accident, i.e. provide First Aid. For example,

- IF ON CLOTHING/ SKIN: Rinse immediately contaminated clothing or skin with plenty of water.
- IF IN EYES: Rinse with water for several minutes.

Source: http://www.acs.org/content/dam/acsorg/education/policies/safety/chemical-safety-for-teachers-and-their-supervisors.pdf

A pictogram, i.e. a pictorial safety sign, may also be included on the label which would quickly communicate the hazard of the chemical.

Thus, chemicals in the laboratory should ideally be labelled as shown in the example below.

Pictogram:

Signal Word:
Danger

Hazard Statement:
Causes severe skin burns and eye damage/ highly corrosive.

Prevention:
- Wear protective gloves, safety goggles and face shield with chin guard.
- Wash arms, hands and face thoroughly after handling.

Response:
- IF ON SKIN: Rinse skin with water.
- IF ON CLOTHING: Rinse immediately contaminated clothing and skin with plenty of water. Wash contaminated clothing before reuse.
- IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
- IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
- Seek medical assistance soon after receiving first aid.

Source: https://www.osha.gov/Publications/OSHA3636.pdf

III: Safety in Science Laboratories

Safety Rules for Teachers

Following points are highly recommended for providing a healthy and safe environment during practical activities:

1. It is highly recommended that a school should develop a Safety Checklist and establish regular inspection schedules and procedures for checking safety and first-aid equipment.

2. Install fire extinguisher(s), sand bucket(s) and fire blanket(s) in easily accessible locations (general rule to follow is that the accessibility of these items should be within 15 seconds or 30 steps from any location in the room). Restock these safety equipment as per need (upon expiry or after usage) and train teachers and students to use them when required.

3. Keep a first-aid box (including bandage tape, gauze, antiseptic, scissors, cotton wool, etc.) in the laboratory.

4. Make certain that the teachers and students wear adequate protective equipment, including laboratory coats, safety goggles and gloves, when experiments are conducted.

5. Clearly mark fire exits, and keep exits unobstructed.

6. Display and follow safety signs. (See Annexure B)

7. Keep water, gas and electricity turned off when not in use.

8. Chemical shelving should be wooden, with a front lip and ventilated.

9. Store flammables and corrosives chemicals separately in suitable cabinets.

10. Do not store flammable liquids in open containers.

11. Make an appropriate system for waste disposal.

12. Make certain that too many appliances are not plugged into one outlet/ socket.

13. Avoid frayed electrical cords or placing electric cords under rugs or near heat sources.

14. The filters in the fume cupboard should be changed at regular intervals.

Safety Rules for Students

Implementing proper laboratory safety procedures as part of instructions reduces the possibility of a teacher or student suffering from an incident or injury. Also, it helps to minimise the losses resulting from accidents and promotes a safe approach in students.

Given is the list of laboratory safety rules recommended to be followed at all times by the students:

1. Conduct yourself in a responsible manner at all times in the laboratory. Practical jokes, pranks and horseplay are strictly prohibited.

2. When entering a science laboratory, avoid touching any equipment, chemicals, electrical and electronic devices, or other materials until you are instructed to do so.

3. Follow all written and verbal instructions carefully given by the teacher/ instructor.

4. Do not start any practical work unless you are clear about its directions. Ask your teacher before proceeding with the activity.

5. Wear a laboratory coat, safety goggles and gloves at all times in the laboratory.

6. Keep your working station clean and tidy.

7. Do not eat or drink in the laboratory.

8. Be cautious at all times in the laboratory. Call the teacher immediately if you notice any risky conditions.

9. Never work alone in the laboratory. PRESENCE OF A TEACHER OR SUPERVISOR IS NECESSARY.

10. Bring only the laboratory instructions and notebook into the laboratory. Other materials (purse, bags, etc.) should be placed outside the laboratory.

11. Read the labels and instructions on the chemicals and electronic devices carefully before use.

12. Keep your hands away from eyes and mouth while using chemicals.

13. Know the locations and operating procedures of all safety equipment, including a first-aid kit, fire extinguisher and fire alarm.

14. Do not place combustibles (paper/ notebooks) near heat source.

15. Do not wear contact lenses in the laboratory.

16. In case of any spillage, breakage or injury, report to the teacher instantly. STAY CALM.

17. If a chemical splashes into your eyes or skin, flush your eyes with running water thoroughly and seek medical attention.

18. Examine glassware before use. Never use chipped, cracked or dirty glassware.

19. Do not taste or smell any chemical present in the laboratory.

20. When recording an observation, keep yourself at least one foot away from the setup.

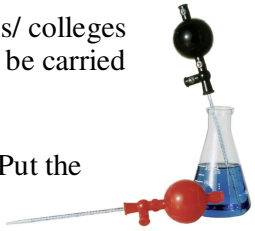
21. Take great care when transferring acid and other corrosive chemicals from one apparatus to another. Hold the apparatus securely as demonstrated by the teacher.

22. When removing an electrical plug from its socket, switch off and grasp the plug, not the electrical cord. Hands must be dry when touching an electrical switch, plug or outlet/ socket.

23. Never return unused chemical to its original container.

24. Do not take any chemical away from the laboratory premises.

25. It is recommended to avoid mouth pipetting. AKU-EB encourages schools/ colleges to use rubber pipette filler. However, if mouth pipetting is done, it should be carried out under a teacher's supervision.



26. Do not immerse hot glassware in cold water as the glassware may break. Put the heated glassware at a separate place to be cooled.

27. Never look into a container that is being heated. Always observe containers from sideways.

28. If the Bunsen burner goes out accidentally, immediately turn off the control device/ gas supply.

29. Never leave a lit burner unattended.

30. While heating a chemical in a test tube, do not point the mouth of the test tube towards yourself or anyone else.

31. Wash your hands with liquid soap and water on leaving the laboratory.

Section IV: Emergency Responses for Laboratory Accidents

Eye splash

Immediately flush the eyes with a gentle stream of clean, temperate water for 15 minutes. Hold the eyelids open.

Thermal burns

If the skin is unbroken, submerge the burned area in clean water. Do not break any blisters.

Cuts and scratches

Keep the injured lying down, and raise the bleeding part higher than the rest of the body if the cut is severe.

Poisoning by ingestion

Do not induce vomiting. Immediately obtain medical assistance.

Poisoning by inhalation

Do not become a victim yourself by exposure to the same poison while rescuing the injured person. Transport the victim to uncontaminated air immediately.

Clothing fire

If your clothing catches fire, immediately drop to the floor and roll. If someone else's clothing catches on fire, knock that person to the floor and roll him around to smoothen the flame.

Laboratory fire

If you cause or discover smoke or fire, PULL the closest alarm and evacuate to the designated space*.

NOTE: Seek medical assistance soon after receiving first aid.

* It is a good safety practice for schools to have a general emergency plan and designated space for gathering in case of an emergency evacuation. This should be communicated to all students and staff through instructions and drills.

Setting up Biology Laboratory

The required materials for biology practical activities that are to be performed over a period of one year with a group of 12 students are recommended below. If the number of groups exceeds, the quantity of material will multiply accordingly.

Secondary School Certificate

S. No.	Prepared Slide	Number of Slide
1.	Amoeba	2
2.	Bacteria (cocci, bacilli)	2 each
3.	Binary fission in amoeba	2
4.	Budding in yeast	2
5.	Cell division by meiosis (division I and division II)	2 each
6.	Cell division by mitosis (prophase metaphase, anaphase and telophase)	2 each
7.	Chlamydomonas	2
8.	Collenchyma tissue	2
9.	Connective tissue	2
10.	Epidermal tissue	2
11.	Epithelial tissue	2
12.	Hydra	2
13.	Muscle tissue	2
14.	Nervous tissue	2
15.	Paramecium	2
16.	Parenchyma tissue	2
17.	Phloem tissue	2
18.	Rhizopus	2
19.	Sclerenchyma tissue	2
20.	Transverse section of villi	2
21.	Xylem tissue	2

Annexure A

Science Apparatus and Consumables

S. No.	Specimen/ Model	Number of Specimen/ Model
1.	Ascaris (roundworm)	2
2.	Butterfly	2
3.	Centipede	2
4.	Dicotyledonous plant	1
5.	Earthworm	2
6.	Fish	2
7.	Fresh aquatic plant (e.g. Hydrilla)	3
8.	Frog	4
9.	Funaria	2
10.	Jelly fish	2
11.	Leech	2
12.	Liver fluke	2
13.	Lizard	2
14.	Model of bird	2
15.	Model of cat	2
16.	Model of human brain	2
17.	Model of human DNA	2
18.	Model of human ear	2
19.	Model of human eye	2
20.	Model of human kidneys	2
21.	Model of human skeleton	2
22.	Monocotyledonous plant	1
23.	Pinus female cone	2
24.	Pinus male cone	2
25.	Plant with variegated leaves	1
26.	Prawn	2

S. No.	Specimen/ Model	Number of Specimen/ Model
27.	Sea star	2
28.	Sea urchin	2
29.	Small aquarium	1
30.	Snail/ unio	2
31.	Sycon	2
32.	Tapeworm	2
33.	Toad	2

S. No.	Reagent/ Material	Quantity
1.	Benedict's solution	100 mL
2.	Cobalt chloride paper	35 pc
3.	Copper sulphate (5% solution)	100 mL
4.	Distilled water	5 L
5.	Flour	500 g
6.	Food items (carbohydrates, proteins and fats sources)	400 g each
7.	Fresh milk	1 L
8.	Ginger	2 pc
9.	Gram seed	30 seeds
10.	Hydrochloric acid (0.1 M solution)	200 mL
11.	Ice	15-20 cubes
12.	Iodine solution	400 mL
13.	Lactobacilli (culture)	1 vial
14.	Maize seed	30 seeds
15.	Methylene blue/ eosin solution	200 mL
16.	Onion	6 pc
17.	Pea seed (fresh and boiled)	500 g each
18.	Pepsin	10 g
19.	Potato	6 pc
20.	Salivary amylase	10 g
21.	Sodium bicarbonate	100 g
22.	Sodium hydroxide/ Potassium hydroxide (0.1 M solution)	200 mL
23.	Starch solution	400 mL
24.	Sugar	500 g
25.	Vaseline	200 g
26.	Yeast (culture)	1 vial

Annexure A

Science Apparatus and Consumables

S. No.	Apparatus	Quantity
1.	Beaker (100 mL, 500 mL)	6 each
2.	Black card paper	1 sheet
3.	Bunsen burner	6 pc
4.	Cellophane tape	1 pc
5.	Compound microscope	6 pc
6.	Cotton wool	300 g
7.	Cover slip	24 pc
8.	Dropper	6 pc
9.	Filter paper	24 pc
10.	Forceps	12 pc
11.	Glass lid	6 pc
12.	Glass slide	24 pc
13.	Graph paper	24 pc
14.	Iron stand	6 pc
15.	Laboratory thermometer (-10 °C to 110 °C)	2 pc
16.	Lamp/ torch	2 pc
17.	Match box	2 pc
18.	Needle/ pointer	6 pc
19.	Paper clip	1 standard packet
20.	Petri dish	12 pc
21.	Refrigerator	1 pc
22.	Ruler	12 pc
23.	Short stem glass funnel	4 pc
24.	Split cork	4 pc
25.	Test tube (medium)	36 pc

S. No.	Apparatus	Quantity
26.	Test tube holder	12 pc
27.	Test tube stand	6 pc
28.	Thermos flask	2 pc
29.	Tracing paper	24 pc
30.	Tripod stand	6 pc
31.	Watch glass/ magnifying glass	12 pc
32.	Water bath	2 pc
33.	Wide-mouthed bottle	4 pc
34.	Wire gauze	6 pc

Higher Secondary School Certificate

S. No.	Prepared Slide	Number of Slide
1.	Amoeba	2
2.	Chlorella	2
3.	Euglena	2
4.	Histology of mammalian ovaries	2
5.	Human blood smear (phagocytes and lymphocytes)	2
6.	Hydra	2
7.	Longitudinal or transverse section of dicotyledonous stem	2
8.	Nostoc	2
9.	Obelia	2
10.	Paramecium	2
11.	Penicillium	2
12.	Plasmodium	2
13.	Rhizopus	2
14.	Spirogyra	2
15.	Yeast	2

S. No.	Specimen/ Model	Number of Specimen/ Model
1.	Ascaris (roundworm)	2
2.	Bird	2
3.	Butterfly	2
4.	Centipede	2
5.	Crab	2
6.	Dog/ rabbit/ monkey/ mouse	2
7.	Earthworm	2
8.	Female cone of Pinus	2
9.	Fish (*Labeo rohita*)/ any other bony fish	2
10.	Flowers of family *Rosaceae, Solanaceae, Fabaceae, Caesalpiniaceae, Mimosaceae* and *Poaceae*	12 each
11.	Frog (for studying features and preparation of temporary slides)	6 preserved 2 fresh
12.	Human skeleton	2
13.	Hydra (either slide or specimen)	2
14.	Leech	2
15.	Liver fluke	2
16.	Lizard	2
17.	Log of a tree	1
18.	Male cone of Pinus	2
19.	Marchantia (female plant)	2
20.	Marchantia (male plant)	2
21.	Mushroom	2
22.	Mussel	2
23.	Photomicrographs of stages of development in chick (cleavage, morulla, blastula and gastrula)	1 each
24.	Planaria	2

S. No.	Specimen/ Model	Number of Specimen/ Model
25.	Reproductive system of a female frog	2
26.	Sea star/ brittle star	2
27.	Snail/ slug	2
28.	Snake (cobra)	2
29.	Spider/ wasp	2
30.	Sycon	2
31.	Tapeworm	2
32.	Ulva	2

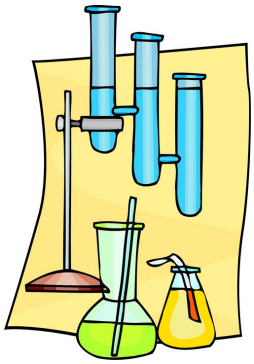
S. No.	Reagent/ Material	Quantity
1.	Acetone (90%)	20 mL
2.	Benedict's solution	100 mL
3.	Copper sulphate solution (5%)	200 mL
4.	Crystal violet	10 g
5.	Dicotyledonous plant (non-woody/ herbaceous for leaf epidermis)	1 pc
6.	Distilled water	5 L
7.	Ethyl alcohol (90%)	150 mL
8.	Glucose	500 g
9.	Goat/ sheep heart	2 pc
10.	Goat/ sheep lungs	2 pc
11.	Gram negative bacteria (culture)	1 vial
12.	Gram positive bacteria (culture)	1 vial
13.	Immersion oil	10 mL
14.	Iodine crystals	20 g
15.	Methylene blue/ eosin	20 g
16.	Onion (for onion epidermis)	2 pc
17.	Petroleum ether (90%)	150 mL
18.	Potted plant	2 pc
19.	Safranin powder	20 g
20.	Salivary amylase	10 g
21.	Sodium hydroxide	20 g
22.	Source of fats	250 g
23.	Source of proteins	250 g
24.	Starch	100 g

Annexure A

Science Apparatus and Consumables

S. No.	Apparatus	Quantity
1.	Beaker (50 mL, 100 mL, 250 mL)	6 each
2.	Bunsen burner	6 pc
3.	Chromatography sheet	1 pc
4.	Common pin	1 standard packet
5.	Compound microscope	6 pc
6.	Cotton wool	300 g
7.	Cover slip	24 pc
8.	Dice	8 pc
9.	Dissection tray	2 pc
10.	Dropper	6 pc
11.	Forceps	6 pc
12.	Glass slide	24 pc
13.	Graduated cylinder (100 mL)	12 pc
14.	Graduated pipette (10 mL)	6 pc
15.	Match box	1 pc
16.	Pestle and mortar	1 pc
17.	Petri dish	12 pc
18.	Pointer/ needle	12 pc
19.	Sphygmomanometer	2 pc
20.	Stethoscope	2 pc
21.	Test tube (medium)	50 pc
22.	Test tube holder	12 pc
23.	Test tube stand	12 pc
24.	Tripod stand	6 pc
25.	Watch glass/ magnifying glass	6 pc
26.	Wire gauze	6 pc
27.	Wooden box for slides (minimum capacity: 30 slides)	1 pc

Setting up Chemistry Laboratory



The required materials for chemistry practical activities that are to be performed over a period of one year with a group of 12 students are recommended below. If the number of groups exceeds, the quantity of material will multiply accordingly.

Secondary School Certificate

S. No.	Reagent	Quantity
1.	Acetone	300 mL
2.	Aluminium sulphate	70 g
3.	Ammonium chloride	70 g
4.	Ammonium hydroxide solution	70 mL
5.	Barium chloride	70 g
6.	Benzoic acid	70 g
7.	Calcium acetate	70 g
8.	Calcium carbonate	70 g
9.	Calcium chloride	200 g
10.	Calcium hydroxide	70 g
11.	Cinnamic acid	50 g
12.	Coconut oil/ any vegetable oil	200 mL
13.	Copper sulphate	120 g
14.	Distilled water	6 L
15.	Ethyl alcohol (98%)	200 mL
16.	Fehling's reagent	25 g
17.	Ferric chloride	70 g
18.	Formaldehyde	70 mL
19.	Glucose	50 g

S. No.	Reagent	Quantity
20.	Hydrochloric acid (concentrated)	350 mL
21.	Iron dust/ filings	120 g
22.	Lime water	350 mL
23.	Manganese dioxide	70 g
24.	Methyl orange	25 g
25.	Naphthalene	50 g
26.	Oxalic acid	250 g
27.	pH paper	100 pc
28.	Phenol	80 g
29.	Phenolphthalein	25 g
30.	Plaster of Paris	1 standard packet
31.	Potash alum	70 g
32.	Potassium chlorate	50 g
33.	Potassium chloride	60 g
34.	Potassium hydroxide	50 g
35.	Potassium permanganate	25 g
36.	Potassium sulphate	60 g
37.	Sand	100 g
38.	Silver nitrate solution	25 mL
39.	Sodium bicarbonate	60 g
40.	Sodium bromide	70 g
41.	Sodium carbonate	70 g
42.	Sodium chloride	350 g
43.	Sodium hydroxide (caustic soda)	50 g
44.	Sodium iodide	70 g
45.	Sodium zeolite	60 g

S. No.	Reagent	Quantity
46.	Strontium chloride	70 g
47.	Sugar	75 g
48.	Sulphur	120 g
49.	Sulphuric acid	200 mL
50.	Tollen's reagent	150 mL
51.	Wax	60 g

Annexure A

Science Apparatus and Consumables

S. No.	Apparatus	Quantity
1.	Bunsen burner	6 pc
2.	Bar magnet	12 pc
3.	Battery	6 pc
4.	Beaker (100 mL, 250 mL, 500 mL)	12 pc each
5.	Torch Bulb	6 pc
6.	Bulb holder	6 pc
7.	Burette (50 mL)	12 pc
8.	Capillary tube	12 pc
9.	China dish	12 pc
10.	Conical flask (250 mL)	24 pc
11.	Connecting wire	12 pc
12.	Cork borer	2 pc
13.	Cork	12 pc
14.	Delivery tube/ bent tube	12 pc
15.	Digital balance	2 pc
16.	Dropper	12 pc
17.	Electrode (iron and copper strip)	12 pc each
18.	Glass funnel	12 pc
19.	Filter stand	12 pc
20.	Fusion tube	6 pc
21.	Glass rod	12 pc
22.	Graduated cylinder (10 mL, 50 mL, 100 mL)	6 pc each
23.	Iron stand with clamp	6 pc
24.	Key	6 pc
25.	Match box	6 pc

S. No.	Apparatus	Quantity
26.	Measuring flask (100 mL, 250 mL, 500 mL, 1000 mL)	6 pc each
27.	One hold stopper/ cork	12 pc
28.	Pair of tongs	6 pc
29.	Pestle and mortar	3 sets
30.	pH paper	2 standard packets
31.	Pipette (10 mL)	12 pc
32.	Safety goggles	12 pc
33.	Stirrer	12 pc
34.	Test tube (medium)	50 pc
35.	Test tube holder	12 pc
36.	Test tube stand	6 pc
37.	Laboratory Thermometer (-10°C to 110°C)	6 pc
38.	Thread	2 spools
39.	Tripod stand	12 pc
40.	Wash bottle	12 pc
41.	Watch glass	12 pc
42.	Whatman filter paper No 1	50 pc
43.	Wire gauze	12 pc

Higher Secondary School Certificate

S. No.	Reagent	Quantity
1.	2,4-dinitrophenyl hydrazine	10 g
2.	Acetic acid (glacial)	150 mL
3.	Acetone	50 mL
4.	Aluminum foil	1 roll
5.	Ammonia solution	75 mL
6.	Ammonium acetate	5 g
7.	Ammonium carbonate	15 g
8.	Ammonium chloride	25 g
9.	Ammonium hydroxide	100 mL
10.	Aniline	100 mL
11.	Barium chloride	25 g
12.	Benedict's solution	200 mL
13.	Bromine water	25 mL
14.	Cadmium chloride/ cadmium nitrate	20 g
15.	Calcium hydroxide	15 g
16.	Carbon disulphide	10 g
17.	Copper sulphate	75 g
18.	Copper turnings	35 g
19.	Dimethyl glyoxime (dissolved in 95% ethyl alcohol)	15 g
20.	Distilled water	3 L
21.	Ethyl alcohol (98%)	300 mL
22.	Fehling's reagent	25 g
23.	Ferric chloride	20 g
24.	Ferrous sulphate	20 g
25.	Ferrous sulphide	10 g

S. No.	Reagent	Quantity
26.	Glucose	35 g
27.	Hydrochloric acid (99%) (dilutions to be used are 0.1 M, 0.2 M, 0.5 M and 1 M)	300 mL
28.	Hydrogen sulphide	10 g
29.	Ink mixture (red, blue, green)	10 mL
30.	Iodine solution	25 mL
31.	Lead acetate	40 g
32.	Litmus powder	5 g
33.	Magnesium sulphate	75 g
34.	Manganese dioxide	15 g
35.	Methyl orange	3 g
36.	Mohr's salt (0.1 M, 0.5 M)	15 g
37.	n-butanol	40 mL
38.	Nessler's reagent	15 g
39.	Nitric acid (99%) (dilutions to be used are 0.1 M, 0.2 M and 0.5 M)	400 mL
40.	Oxalic acid	15 g
41.	Phenol	80 g
42.	Phenolphthalein	3 g
43.	Potassium chromate	15 g
44.	Potassium dichromate	15 g
45.	Potassium ferrocyanide	15 g
46.	Potassium hydroxide	15 g
47.	Potassium iodide	25 g
48.	Potassium oxalate	10 g
49.	Potassium permanganate	10 g

S. No.	Reagent	Quantity
50.	Potassium sulphate	10 g
51.	Salivary amylase	5 g
52.	Salts of the following cations: NH_4^+, Mg^{2+}, Al^{3+}, Ca^{2+}, Ni^{2+}, Co^{2+}, Fe^{2+}, Fe^{3+}, Cu^{2+}, Zn^{2+}, Ba^{2+}, Pb^{2+}	20 g each
53.	Salts of the following anions: CO_3^{2-}, NO_3^-, NO_2^-, SO_4^{2-}, SO_3^{2-}, Cl^-, Br^-, I^-, CrO_4^{2-}	20 g each
54.	Silver nitrate	10 g
55.	Sodium bicarbonate	15 g
56.	Sodium carbonate	35 g
57.	Sodium chloride	25 g
58.	Sodium cobalt initrite	5 g
59.	Sodium hydrogen phosphate	15 g
60.	Sodium hydroxide	35 g
61.	Sodium nitrate	25 g
62.	Sodium nitrite	15 g
63.	Sodium nitroprusside	25 g
64.	Sodium phosphate	15 g
65.	Starch	35 g
66.	Sulphuric acid (99%) (dilutions to be used are 0.1 M, 0.2 M and 0.5 M)	300 mL
67.	Tollen's reagent	150 mL
68.	Urea	40 g
69.	Vegetable oil	35 mL

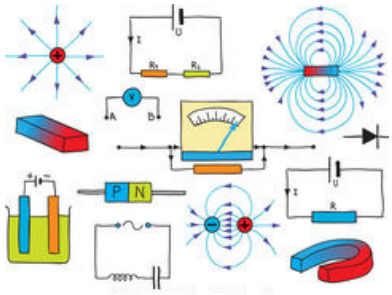
Annexure A

Science Apparatus and Consumables

S. No.	Apparatus	Quantity
1.	Beaker (100 mL, 250 mL, 500 mL)	6 pc each
2.	Bunsen burner	6 pc
3.	Burette (50 mL)	12 pc
4.	Calorimeter	6 pc
5.	Capillary tubes	12 pc
6.	China dish	6 pc
7.	Chromatography jar	12 pc
8.	Conical flask (250 mL)	24 pc
9.	Desiccator	2 pc
10.	Digital balance	2 pc
11.	Dropper	12 pc
12.	Filter funnel	12 pc
13.	Filter stand	12 pc
14.	Glass rod	12 pc
15.	Glass tubing	220 inches
16.	Iron stand	12 pc
17.	Litmus paper (blue)	24 strips
18.	Litmus paper (red)	24 strips
19.	Match box	6 pc
20.	Measuring cylinder (10 mL, 50 mL, 100 mL)	6 pc each
21.	Oven	1 pc
22.	Petri dish	12 pc
23.	Pipette (10 mL)	12 pc
24.	Round bottom flask (250 mL)	6 pc
25.	Safety goggles	12 pc

S. No.	Apparatus	Quantity
26.	Spatula	12 pc
27.	Stirrer	6 pc
28.	Test tube (medium)	50 pc
29.	Test tube holder	12 pc
30.	Test tube stand	6 pc
31.	Laboratory Thermometer (-10 °C to 110 °C)	6 pc
32.	Thistle funnel	6 pc
33.	Tripod stand	12 pc
34.	Wash bottle	6 pc
35.	Whatman filter paper No 1	50 pc
36.	Whatman filter paper No 42	24 pc
37.	Wire gauze	12 pc

Setting up Physics Laboratory



The required materials for physics practical activities that are to be performed over a period of one year with a group of 12 students are recommended below. If the number of groups exceeds, the quantity of material will multiply accordingly.

Secondary School Certificate

S. No.	Apparatus/ Equipment	Quantity
1.	Ammeter (standard)	15 pc
2.	AND gate (7408)	8 pc
3.	Angle iron	6 pc
4.	Beaker (100 mL, 250 mL)	12 pc each
5.	Black board chalk	1 standard packet
6.	Bunsen burner/ spirit lamp	6 pc
7.	Candle	4 pc
8.	Cell box (two cells capacity)	12 pc
9.	Circular coil of insulated copper fitted in a board	12 pc
10.	Common pin	2 standard packets
11.	Concave mirror	12 pc
12.	Concave mirror holder	12 pc
13.	Connecting wire	4 m
14.	Convex lens	12 pc
15.	Copper wire	100 cm
16.	Cork	12 pc
17.	DC power supply (0 to 6 V)	6 pc
18.	Drawing board	12 pc
19.	Dry cell (1.5 V)	24 pc
20.	Fractional resistance box	8 pc
21.	Free fall apparatus	6 pc

S. No.	Apparatus/ Equipment	Quantity
22.	Galvanometer (0 to 30 divisions)	6 pc
23.	Glass prism	12 pc
24.	Glass slab	12 pc
25.	Gravesand's apparatus	6 pc
26.	Helical spring with stand	12 sets
27.	Hypsometer	6 pc
28.	Iron ball	6 pc
29.	Iron stand	12 pc
30.	Key plug	12 pc
31.	Laboratory thermometer (-10 °C to 110 °C)	12 pc
32.	Magnetic compass	18 pc
33.	Match box	12 pc
34.	Metallic bob with hook (aluminium/ brass/ iron/ steel)	12 sets
35.	Metallic shot	6 sets
36.	Meter rod/ scale	12 pc
37.	Needle with stand	12 pc
38.	OR gate (7432)	8 pc
39.	Pan	6 pc
40.	Physical/ digital balance	6 pc
41.	Pinch cork	12 pc
42.	Plane mirror strip	12 pc
43.	Plumb line	6 pc
44.	Polystyrene cup with lid and stirrer	12 pc
45.	Resistance box (1 to 5000 ohms)	8 pc
46.	Rheostat	12 pc
47.	Sand paper	6 pc

S. No.	Apparatus/ Equipment	Quantity
48.	Scissors	6 pc
49.	Screw gauge	12 pc
50.	Slotted weight with hanger (20 g)	12 sets
51.	Solid cylinder	12 pc
52.	Split cork	12 pc
53.	Spring balance	12 pc
54.	Stop watch	12 pc
55.	Thread	4 spools
56.	Thumb pin	6 standard packets
57.	Two way key plug	6 pc
58.	Unknown resistance	12 pc
59.	Vernier calipers	12 pc
60.	Voltmeter (standard)	15 pc
61.	Weight box	6 pc
62.	Wooden bench	12 pc
63.	Wooden wedge	6 pc

Higher Secondary School Certificate

S. No.	Apparatus/ Equipment	Quantity
1.	Ammeters (0 to 3 A)	6 pc
2.	Ammonium chloride	100 g
3.	Beaker (100 mL, 1000 mL)	8 pc each
4.	Burglar's Alarm	6 pc
5.	Capacitor (10 μF to 100 μF)	6 pc each
6.	Car bulb with holder (12 V)	6 pc
7.	Cell box (two cells capacity)	12 pc
8.	Connecting wire	4 m
9.	Copper sulphate (crystals)	100 g
10.	Cork	12 pc
11.	Daniell cell (1.0 V)	6 pc
12.	Dry cell (1.5 V)	24 pc
13.	Electric calorimeter	6 pc
14.	Electric oscillator/ AC vibrator	6 pc
15.	Electronic timer with power supply	4 pc
16.	Galvanometer (0 to 30 divisions)	6 pc
17.	Gravesand's apparatus with pulleys	6 pc
18.	Heat sensor	6 pc
19.	Iron stand with clamps	12 pc
20.	Jockey	6 pc
21.	Key (one way and two way)	6 pc each
22.	Laboratory thermometer (-10 °C to 110 °C)	6 pc
23.	Leclanche cell (1.4 V)	6 pc
24.	Metallic bob (aluminium/ brass/ iron/ steel)	12 pc
25.	Meter rod/ ruler	12 pc

S. No.	Apparatus/ Equipment	Quantity
26.	Micro ammeter	6 pc
27.	Milli ammeter	6 pc
28.	NPN transistor	6 pc
29.	Optical pin/ pointer	12 pc
30.	OR, AND, NOR, NAND, NOT gates	2 sets
31.	Photo cell	6 pc
32.	Physical/ digital balance	4 pc
33.	Pivot/ moment stand	6 pc
34.	Plane glass plate	12 pc
35.	Plane mirror strip	6 pc
36.	Plumb line	6 pc
37.	Potentiometer	6 pc
38.	Power supply (DC) (1 volt to 15 volts)	6 pc
39.	Pulley with stand	6 pc
40.	Resistance box (0 Ω to 10 kΩ)	6 pc
41.	Resistance box (0 Ω to 500 Ω)	6 pc
42.	Resonance tube	8 pc
43.	Roll of ticker timer	1 pc
44.	Rubber pad	6 pc
45.	Screw gauge	12 pc
46.	Sellotape	1 pc
47.	Semi-conductor diode	6 pc
48.	Shunt wire	6 pc
49.	Slide wire bridge	6 pc
50.	Slotted weight (500 g)	30 pc
51.	Slotted weight with hanger (20 g)	36 sets

S. No.	Apparatus/ Equipment	Quantity
52.	Smoke sensor	6 pc
53.	Sonometer	6 pc
54.	Spherical glass plate	12 pc
55.	Spherometer	12 pc
56.	Stands with clamps	12 pc
57.	Steel ball bearing of 6.5 mm to 12.5 mm diameter	6 each
58.	Stop watch	12 pc
59.	Test tube (small)	12 pc
60.	Thread	6 spools
61.	Ticker tape vibrator	2 pc
62.	Ticker-timer	4 pc
63.	Tuning forks (480 Hz, 512 Hz)	6 pc each
64.	Variable resistances up to 300 Ω	12 pc
65.	Vernier calipers (15 cm long)	12 pc
66.	Voltmeters (0 V to 15 V)	6 pc
67.	Weight box	4 pc
68.	Wires (diameter: 0.125 mm, 0.25 mm, 0.35 mm)	2 m each
69.	Zinc rods	12 pc

Setting up Computer Science Laboratory

Following are the minimum standards to be followed in computer science laboratories at the **Secondary** and **Higher Secondary School Certificate** levels:

1. The laboratory room should have proper lighting and ventilation.
2. The laboratory should be spacious and equipped with appropriate and comfortable furniture.
3. All computer systems should be in working order.
4. There should be one system per student.
5. There should be at least one printer attached for every six computers.
6. A CD-burner should be installed in the computer laboratory to facilitate archiving of students' work.
7. Students should have access to the Internet, Microsoft Office and the prescribed programming language (for SSC II: GW BASIC, for HSSC II: C Language and Visual Basic).
8. Ideally, all computers should be connected with an Uninterrupted Power Supply (UPS) and, if possible, a generator during the examinations.

Safety Sign	Meaning
	Danger (general sign)
	Flammable Material
	Corrosive Material
	Oxidizing Material
	Heated/ Hot Surface
	Toxic
	High Voltage
	Carcinogenic

Radioactive

Environmental Hazard

Explosive

Source: http://www.seton.com/labels-decals/osha-safety/safety/iso-symbol-labels/iso-mandatory-labels.html

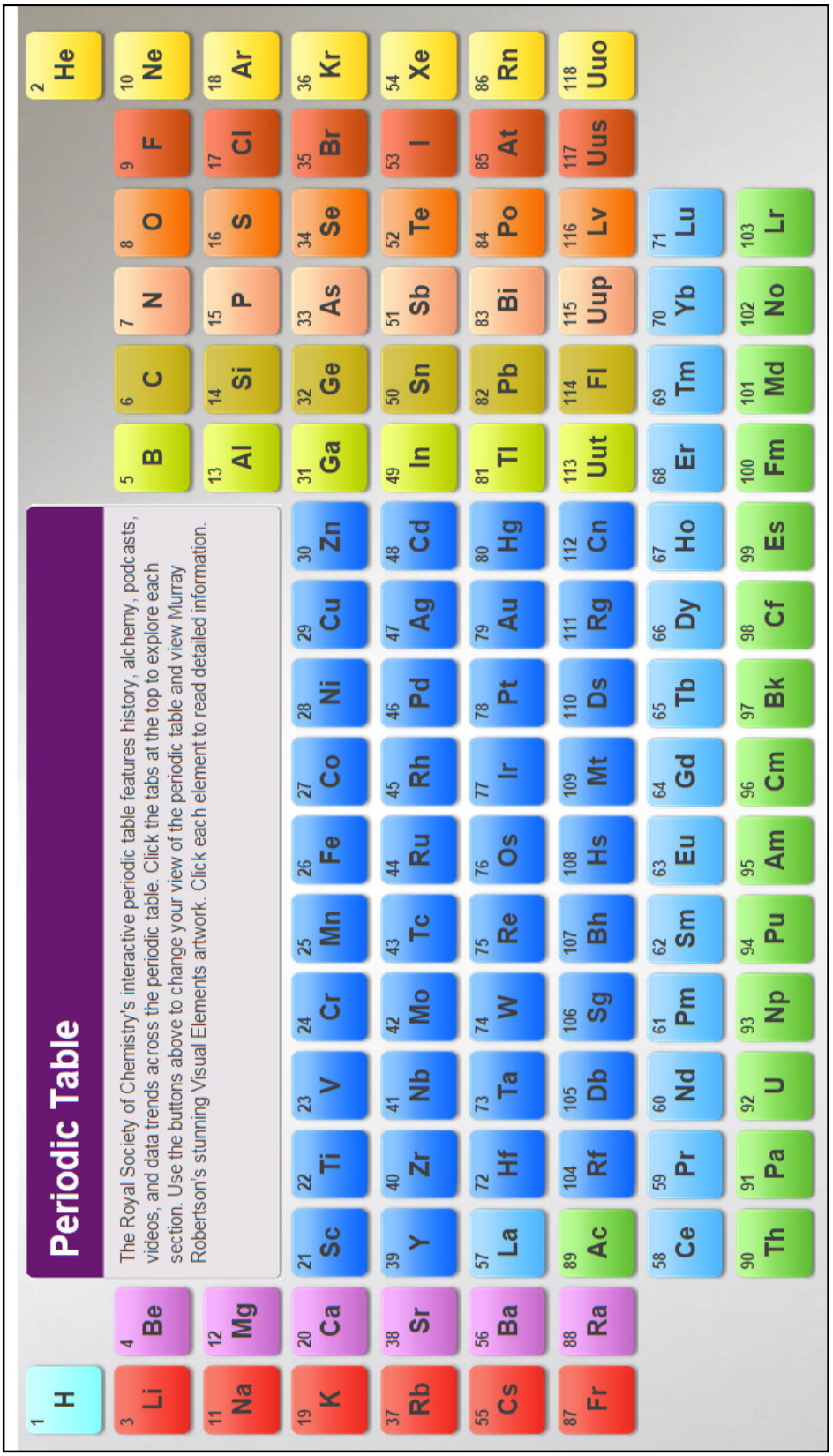
Table 1. SI base units		
	SI base unit	
Base quantity	**Name**	**Symbol**
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

Table 2. Examples of SI derived units		
	SI derived unit	
Derived quantity	**Name**	**Symbol**
area	square meter	m^2
volume	cubic meter	m^3
speed, velocity	meter per second	m/s
acceleration	meter per second squared	m/s^2
wave number	reciprocal meter	m^{-1}
mass density	kilogram per cubic meter	kg/m^3
specific volume	cubic meter per kilogram	m^3/kg
current density	ampere per square meter	A/m^2
magnetic field strength	ampere per meter	A/m
amount-of-substance concentration	mole per cubic meter	mol/m^3
luminance	candela per square meter	cd/m^2
mass fraction	kilogram per kilogram, which may be represented by the number 1	kg/kg = 1

Table 3. SI derived units with special names and symbols				
	SI derived unit			
Derived quantity	**Name**	**Symbol**	**Expression in terms of other SI units**	**Expression in terms of SI base units**
plane angle	radian [(a)]	rad	-	$m \cdot m^{-1} = 1$ [(b)]
solid angle	steradian [(a)]	sr [(c)]	-	$m^2 \cdot m^{-2} = 1$ [(b)]
frequency	hertz	Hz	-	s^{-1}
force	newton	N	-	$m \cdot kg \cdot s^{-2}$
pressure, stress	pascal	Pa	N/m^2	$m^{-1} \cdot kg \cdot s^{-2}$
energy, work, quantity of heat	joule	J	$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
power, radiant flux	watt	W	J/s	$m^2 \cdot kg \cdot s^{-3}$
electric charge, quantity of electricity	coulomb	C	-	$s \cdot A$
electric potential difference, electromotive force	volt	V	W/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$
capacitance	farad	F	C/V	$m^{-2} \cdot kg^{-1} \cdot s^4 \cdot A^2$
electric resistance	ohm	Ω	V/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
electric conductance	siemens	S	A/V	$m^{-2} \cdot kg^{-1} \cdot s^3 \cdot A^2$
magnetic flux	weber	Wb	$V \cdot s$	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-1}$
magnetic flux density	tesla	T	Wb/m^2	$kg \cdot s^{-2} \cdot A^{-1}$
inductance	henry	H	Wb/A	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-2}$
Celsius temperature	degree Celsius	°C	-	K
luminous flux	lumen	lm	$cd \cdot sr$ [(c)]	$m^2 \cdot m^{-2} \cdot cd = cd$
illuminance	lux	lx	lm/m^2	$m^2 \cdot m^{-4} \cdot cd = m^{-2} \cdot cd$
activity (of a radionuclide)	becquerel	Bq	-	s^{-1}
absorbed dose, specific energy (imparted), kerma	gray	Gy	J/kg	$m^2 \cdot s^{-2}$
dose equivalent [(d)]	sievert	Sv	J/kg	$m^2 \cdot s^{-2}$
catalytic activity	katal	kat		$s^{-1} \cdot mol$

Table 4. Examples of SI derived units whose names and symbols include SI derived units with special names and symbols		
	SI derived unit	
Derived quantity	**Name**	**Symbol**
dynamic viscosity	pascal second	Pa·s
moment of force	newton meter	N·m
surface tension	newton per meter	N/m
angular velocity	radian per second	rad/s
angular acceleration	radian per second squared	rad/s^2
heat flux density, irradiance	watt per square meter	W/m^2
heat capacity, entropy	joule per kelvin	J/K
specific heat capacity, specific entropy	joule per kilogram kelvin	J/(kg·K)
specific energy	joule per kilogram	J/kg
thermal conductivity	watt per meter kelvin	W/(m·K)
energy density	joule per cubic meter	J/m^3
electric field strength	volt per meter	V/m
electric charge density	coulomb per cubic meter	C/m^3
electric flux density	coulomb per square meter	C/m^2
permittivity	farad per meter	F/m
permeability	henry per meter	H/m
molar energy	joule per mole	J/mol
molar entropy, molar heat capacity	joule per mole kelvin	J/(mol·K)
exposure (x and γ rays)	coulomb per kilogram	C/kg
absorbed dose rate	gray per second	Gy/s
radiant intensity	watt per steradian	W/sr
radiance	watt per square meter steradian	$W/(m^2 \cdot sr)$
catalytic (activity) concentration	katal per cubic meter	kat/m^3

Source: http://physics.nist.gov/cuu/Units/units.html



Source: http://www.rsc.org/periodic-table

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